

# Objective Diagnosis of Human Death

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The successful transplanting of human hearts has raised profound ethical and medical-legal questions. Probably the key questions are: When does human death occur? How can it be diagnosed objectively?

Death has until recently been assumed to be an instantaneous event. The idea in its simplest form was expressed in the biblical notion that the "breath of life" entered the inert body of Adam to make him alive. Death has been assumed to be due to the exit of the "breath of life."

Until recently medicine has in effect accepted these ideas. Its only refinement is that knowledge of the importance of the circulatory system has led physicians to add the cessation of heart action to the cessation of breathing as criteria for determining the instant of death.

In an attempt to shed light on the foregoing questions, I shall first show that human beings in fact enjoy three separate kinds of life and so undergo three separate deaths.

## Anatomical and Physicochemical Distinctions Between the Three Levels of Life and Death

Several years ago I had occasion to point out a mechanism whereby organismal aging and aging death could occur without having any vital cells of the organism die. In doing this a sharp distinction was made between reversible organismal (or physiological) death and irreversible death due to chemical disorganization of the cells of the vegetative brain. Surprisingly, at that time I could find no scientific definitions of death anywhere.

Subsequently it has become apparent to me that a third level of irreversible death

—death of the cerebral cortex or psychic death—also can be sharply distinguished from vegetative death. Naturally, the three levels of death must each be the result of terminating the three related levels of life. But since it is easier to distinguish these levels of life by defining their absence—that is, identifying the three levels of death—we shall do this first by means of a simple chart (Table 1).

*Organismal death* is characterized by the fact that—due to electric shock, drowning, anesthesia, or certain other conditions—the heart and lungs stop functioning, and the individual loses consciousness; and unless promptly resuscitated he will in a matter of minutes be irreversibly and permanently dead. But if resuscitated within five minutes such an individual can be fully revived without suffering any permanent physical damage. In that case death has been completely reversible. Obviously none of the brain cells were damaged by the brief period of anoxia. As is well established, such organismal death is due to a disruption of the nervous communications between the cells of the vegetative brain and the heart, and between the cells of the vegetative brain and those of the diaphragm and other muscles involved in breathing. In other words, it is *inter cellular*—a physiological and not a cellular event. Consequently no *intra cellular* damage is involved. Therefore such people recover completely without permanent physical damage of any kind.

*Psychic death.* If resuscitation is delayed longer than 5 minutes, so that anoxia lasts from 5 to 8 minutes, it then is possible in some cases to restore the individual to a limited form of organismal life—a form in

Table 1. The Time Intervals Separating the Different Levels of Death \*

Organismal Death			Psychic Death		Vegetative Death
0	2	4	5	6	8 minutes of brain anoxia

\* It needs to be acknowledged that the figures of 5 and 8 minutes are not quite as absolute as they are used here. These are average figures based on clinical experiences which are not always accurately timed. Young people and people who are chilled withstand longer periods of anoxia of their brains than older people or people whose body temperature is normal.

which the individual remains in a state of permanent coma. What has happened, in such cases, of course, is that the cells of the cerebral cortex have been destroyed by the prolonged anoxia, thus ending all possibility of psychic life for that individual. Obviously, since organismal life has been restored to all parts of the body except the cortex, it is clear that the cells of the vegetative brain had not been seriously damaged by the few minutes of anoxia.

*Vegetative death.* If anoxia persists beyond 8 minutes, then the cells of the vegetative brain also die. Naturally when that occurs, not even the purely vegetative form of organismal life is possible.

This brief recapitulation makes it apparent that there are three clearly and objectively distinguishable forms of death—organismal death due to physiological disorganization, and two other forms of death that are due to chemical disorganization of brain cells. But the two latter types of cellular disorganization involve entirely different parts of the brain and occur at different points in time. To prove that these are different kinds of death and not mere stages of a single death process, it is only necessary to point out that people who recover from organismal death often live on for years before their final irreversible death occurs. Also, in cases of prolonged coma, vegetative death is delayed for months or even years after psychic death has occurred. These facts make it evident that although these three forms, or

levels, of death usually occur in rapid sequence, they nevertheless are clearly distinguishable entities which can be objectively distinguished from each other.

It should be said at this point that in many cases the cells of the heart, kidneys, and liver survive for some time after all three forms of death have occurred. If this were not the case it would be impossible to salvage organs from cadavers.

Let us now turn our attention to the three corresponding levels of life. The first question that naturally arises is this: *Do the different levels of life begin at different times in embryological and foetal development?*

It is not necessary to delve very deeply into embryology to become convinced that the three levels of life do in fact begin at different times.

As every student of embryology knows, an unfertilized egg has only half the total chromosomes normally found in the cells of the species. Fertilization restores the total number of chromosomes normal for the species. After fertilization occurs the cell begins to grow and soon multiplies to form 2 . . . 4 . . . 8 . . . 16, etc., cells. Eventually, in an adult human being the total number of cells finally reaches an estimated total of from 30 to 50 trillion cells.

There is good evidence that until the 16-cell stage is reached, each of the earlier cells has the full potentialities of the original fertilized egg. This is based on the fact that quintuplets are supposedly the result



of the cells at the eight-cell stage becoming separated to form 5, 6, 7, or 8 embryos. But a uterus apparently is only large enough to accommodate no more than five, so the others almost always die.

Since undifferentiated cells are an indication that no form of specialization or cellular cooperation has yet begun, it therefore follows that organismal life has not yet begun. By definition, organismal life implies intercellular cooperation. Though the matter can undoubtedly stand more investigation, it appears that cellular differentiation and specialization begins with the 16-cell stage in the development of the blastula. Certainly it does not occur earlier than the 16-cell stage, but by the time the blastula is ready to be transformed into the gastrula form, differentiation and intercellular cooperation have gone a long way and primitive intercellular endocrine controls and cell cooperation are present. Clearly, a primitive form of organismal life has certainly begun by that time. But at the gastrula stage there still is no activity that suggests functions of the kind we ordinarily associate with psychic or vegetative life. Heart and vessels, lungs and nervous system have not yet reached a stage where they exhibit the kinds of activity which we normally associate with those organs.

The best evidence we have regarding the time when vegetative (and possibly psychic) life begins is the fact that EEG and ECG waves have been obtained from 43- to 45-day embryos but not from younger ones. At the 43-45 day stage the heart begins to beat rhythmically and the brain begins to produce EEG waves. We may conclude, therefore, that vegetative life begins at or about age 43 to 45 days. But what about psychic life?

Defining the exact time when psychic life begins seems more difficult. In fact, the exact anatomical boundaries which separate the vegetative from the cortical parts of the brain are not entirely clear. Defining the beginning of psychic life requires us to answer the still more difficult questions: When does the cortex begin to store bits

of information? When does it begin to function—to transform sensations into perceptions? When does it begin to create thoughts? There is considerable evidence that the storage of recallable experiences begins before birth. And the ability to think and reason is displayed in quite young babies. On the other hand, self-consciousness, which appears to be the beginning of *true* human consciousness, does not occur until a child is several years old.

### Discussion

This brief outline of the evidence for three different kinds of life and death seems to demonstrate both their reality and the importance of recognizing these levels in order to answer the questions proposed at the beginning.

At this point it is necessary to draw attention to the word "human" in the title. It is clear that all forms of multicellular animals possess both organismal and vegetative life. And many sub-human species also exhibit animal forms of psychic life.

But no animal has ever created a symphony, or invented a language, or developed a scientific theory. Clearly, the psychic life of man enables him to perform feats of imagination and creativity that are in a different category from any activity that the most intelligent animals can perform. These feats of imagination and creativity are the product of cortical (psychic) activity of the human brain. In ways which are not yet well understood, man is able to rearrange his stored memories to create new ideas. If we accept, therefore, the idea that the part of a man which truly distinguishes him from animals is his cerebral cortex, then clearly *human* death must be related to the death of the cortex—psychic death.

Since psychic death can occur before the other kinds of death occur, and also before death occurs in the cells of various organs such as those of kidneys, livers, or hearts, it can be said that human death and psychic death are identical.

Though the technique can no doubt

stand further refinement, it seems clear that the encephalogram is the tool which will enable us to decide when irreversible psychic death has occurred—even when vegetative and organismal life continue.

## T-THOUGHTS

### Chinese Baseball

Now that the World Series is in the air, I am reminded of some sporting advice on acquiring managerial finesse in Washington. To quote my old Master:

“So you’re going to Washington, eh?”

“Yes, Sir,” I replied.

“Well, son,” he warned, “you’d better be good at Chinese baseball—that’s for sure!”

After I inquired about the nature of the game, he explained:

“Chinese baseball is played almost exactly like American baseball—same number of players, same balls, same bats, same scoring, and so on. The batter stands in the batter’s box as usual, and the pitcher winds up as usual. However, there is one important difference. After the ball leaves the pitcher’s hand, and as long as it is in the air, *anyone* can move *any* of the bases *anywhere!*”

### Direction of Basic Research

The following is the comment of one Nobel laureate (Mme. Joliot-Curie) about another:

“You cannot direct research. Research must direct you. If my mother had been directed in her researches she would have found small things. She never would have discovered radium.”

### Surface Phenomenon

There seems to be a tendency to solve management difficulties by interposing another echelon.

Perhaps “Judge” Kindelberger of North American Aviation preached a cogent lesson when he appeared before the Senate Preparedness Committee a couple of years

ago. He said that the state of one of our larger Government agencies reminded him “of a skein of yarn with which the cat had been playing for years—it is badly snarled and loose ends stick out all over. . . . It cannot be disentangled by wrapping more yarn on the outside. It is a vast, intricate thing and I do not think you can wind another committee or another czar or another group on the outside of a tangle and straighten out the tangle.”

### Research Philosophy

Here’s a bit of philosophy taken off the wall of Dr. C. S. Draper at Fort Eustis:

“Research is a gamble. It cannot be conducted according to the rules of efficiency engineering. Research must be lavish of ideas, money, and time. The best advice is, Don’t quit easily. Don’t trust anyone’s judgment but your own; especially, don’t take advice from any commercial person or financial expert.

“And finally, if you really don’t know what to do, match for it. The best man to decide what research work shall be done is the man who is doing the research. The next best man is the head of the department. After that you leave the field of best persons and meet increasingly worse groups. The first of these is the research director, who probably is wrong more than half the time. Then comes a committee which is wrong most of the time. Finally there is the committee of company vice presidents which is wrong all of the time.”

### Able, Willing, and Necessary

In a previous T-Thought I forgot to clarify the definition of a committee. So here it is:

Committee: The unable who have been asked by the unwilling to do the unnecessary.

—Ralph G. H. Siu

